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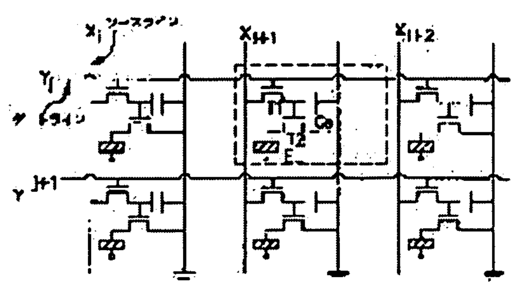
(54) TFT-EL DISPLAY PANEL USING ORGANIC ELECTROLUMINESCENCE MEDIUM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a flat panel made of thin film transistor electroluminescence(TFT-EL) picture elements.
SOLUTION: Two TFTs and a memory capacitor are utilized, so as to keep EL picture elements on a panel operable nearly at a 100% duty factor. A TFT-EL device eliminates the need of patterning an EL cathode, thereby establishing a high resolution. At the same time, a process for delineating the contours of the EL picture elements is remarkably simplified. Also, a TFT-EL panel consumes electric power less than the TFT-LCD panel manufactured by use of the conventional technology, particularly when the utilization factor of a screen is less than 1.



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CLAIMS

[Claim(s)]
[Claim 1] It is the electroluminescence flat-surface panel drop which consists of a substrate which it has [substrate] a top face and a base and had two or more pixels arranged on it, and each of this pixel is :a. It is the first thin film transistor which it is arranged on the top face of this substrate, and becomes from a source electrode, a drain electrode, a gate dielectric, and a gate electrode, and this gate electrode becomes from some gate buses.;
b) It is the second thin film transistor which is arranged on the top face of this substrate and consists of a source electrode, a drain electrode, a gate dielectric, and a gate electrode and by which this gate electrode is electrically connected to the drain electrode of this first thin film transistor.;
c) Capacitor which is arranged on the top face of this substrate and consists of the upper part and a pars-basilaris-ossis-occipitalis electrode;
d) Display anode plate layer electrically connected to the drain electrode of this second thin film transistor;
e) Dielectric passivation layer which has the edge which overlays this first and the second thin film transistor, and this capacitor, has opening on this anode plate layer, and has a taper by this opening so that a bottom edge may extend further from upper limit on this anode plate layer;
f) Organic electroluminescence layer which is directly arranged on the top face of this anode plate layer, and is insulated from this first and the second thin film transistor, and this capacitor by this passivation layer;
g) The electroluminescence flat-surface panel drop which contains further two or more train leads which consisted of the catholyte and; which are directly arranged on the top face of this organic electroluminescence layer, and were connected to the source electrode of this first thin film transistor on each pixel, two or more line leads connected to the gate electrode of this first thin film transistor on each pixel, and two or more ground leads connected to this capacitor on each pixel.
[Claim 2] This cathode is a flat-surface panel drop according to claim 1 which is the continuation sheet which overlays these two or more pixels.
[Claim 3] It is the flat-surface panel drop according to claim 1 which has 1000 lines and 1000 trains, each of this pixel is abbreviation 0.2mmx0.2mm, has the time average brightness of about 20 fL(s), and has power consumption smaller than about 7W during actuation.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001] It applies to coincidence and both U.S. country patent application 08/355940 "A Method of Fabricating a TFT-EL Pixel" by the U.S. country patent application 08/355786 by Cross-reference Tang etc. "An Electroluminescent Device Having an Organic Electroluminescent Layer", Tang, etc. of related application quotes the description here.
[0002]
[Field of the Invention] This invention relates to the electroluminescence display panel which used the organic electroluminescence thin film as a thin film transistor (TFT) and a radiation medium as an active matrix addressing element.
[0003]
[Description of the Prior Art] Rapid development of a flat panel drop (FPD) technique made possible a high quality large field, full color, and a high resolution drop. These drops enabled new application with a laptop computer or an electronic product like Pocket TV. The liquid crystal display (LCD) appeared as selection of the drop in a commercial scene in these FPD techniques. It set up the technical standards with which other FPD techniques are compared again. LCD -- a panel -- an example -- the following -- containing -- : -- (-- one --) -- a workstation -- ** -- 14 -- " -- 16 - a color -- LCD -- a panel (IBM and Toshiba --) 1989 (see SID Digest by KIchikawa, S.Suzuki, H.Matino, T.Aoki, T.Higuchi, Y.Oano, etc., and 226 (1989)), (2) -- 6" -- full color LCD-TV (Philips --) 1987 It Hemmings(es). M. -- J.Powell, J.A.Chapman, A.G.Knapp, I.D.French, J.R.Hughes, A.D.Pearson, M.Allinson, M.J.Edwards, R.A.Ford, and M.C. -- O. Proceeding by F.Hill, D.H.Nicholls, N.KWright, etc., International Display Conference, and 63 and 1987 are referred to. (3) -- 4" -- full color LCD-TV (model LQ 424A01) (see the Sharp Corporation Technical Literature for model LQ424A01) -- (4) One mega pixel color TFT-LCD (General Electric) (D. refer to E.Castleberry, SID Digest by G.E.Possin, and 232 (1988)). All the bibliographies containing a patent and a publication are quoted here so that it may reappear completely below.
[0004] The common description in these LCD panels is use of a thin film transistor (TFT) in an active addressing method, and this eases a limit of direct addressing (S. refer to Advances in Electronics and Electron Physics by Morozumi, P.W.Hawkes edit, Vol.77, and Academic Press 1990). It is most that a success of a LCD technique is based on the rapid advance of manufacture of the large field TFT (mainly amorphous silicon TFT). The almost ideal adaptation between a TFT switching characteristic and a electron optics LCD display element plays a role of a key again.
[0005] The main faults of a TFT-LCD panel are that a bright back light is the need. The transmission coefficient of this of TFT-LCD is because it is small especially by the color panel. Typically, a transmission coefficient is about 2 to 3% (S. refer to Advances in Electronics and ElectronPhysics by Morozumi, P.W.Hawkes edit, Vol.77, and AcademicPress 1990). The power consumption to a TFT-LCD panel with a back light is remarkable, and it influences so that it may go back to application of the pocket mold drop which needs dc-battery actuation.
[0006] The need for a back light spoils the miniaturization of a flat panel again. For example, it must be increased by the depth of a panel in order to contain a back light unit. When the cold cathode lamp of the

shape of typical tubing is used, about 3/of additional depth is 4 to 1 inch. A back light applies excessive weight to FPD again. The ideal solution to the above-mentioned limit is a low power radiation drop which removes the need for a back light. Especially an attractive candidate is a thin film transistor electroluminescence (TFT-EL) drop. The address of each pixel is carried out so that light may be emitted, and an auxiliary back light is not required of a TFT-EL indicator. The TFT-EL method was proposed by Fischer in 1971 (A. refer to IEEE Trans.Electron Devices by G.Fischer, and 802 (971)). ZnS to which disintegration of the method of Fischer was carried out is used as an EL medium.
[0007] It was reported that the TFT-EL panel (6") of the prototype which was successful in 1975 was made by Brody using CdSe as a TFT ingredient etc. by using ZnS as EL element (T. refer to IEEE Trans.ElectronDevices by P.Brody, F.C.Luo, A.P.Szepesi, D.H.Davies, etc., and 22,739 (1975)). Since ZnS-EL needs high driver voltage 100 volts or more, it is Switching CdSe. A TFT element must be designed so that such high-voltage vibration may be treated. Then, the dependability of the high voltage TFT became doubtful. Ultimately, TFT-EL based on ZnS did not succeed in competition with TFT-LCD. : whose U.S. country patent which indicates a TFT-EL technique is as follows -- No. 3807037, No. 3885196, No. 3913090, No. 4006383, No. 4042854, No. 4523189, and No. 4602192.
[0008] The organic electroluminescence ingredient has been device-ized in recent years. These ingredients suggest itself as a candidate to the display medium in a TFT-EL device (C. refer to J.Appl.Phys. by Appl.Phys.Lett. by W.Tang and S.A.VanSlyke, 51,913 (1987) and C.W.Tang, S.A.VanSlyke, and C.H.Chen, and 65 and 3610 (1989)). : in which an organic electroluminescence medium has two important advantages --; which has the effectiveness in which they are higher -- they have a low electrical-potential-difference demand. The latter property differs from other thin film radiation devices. : with the following indication of the TFT-EL device whose EL is an organic material -- the U.S. country patent No. 5,073,446, No. 5,047,687,; of 5,059,861 No. No. 5,294,870, No. 5,151,629, No. 5,276,380, No. 5,061,569, No. 4,720,432, No. 4,539,507, No. 5,150,006, No. 4,950,950, and No. 4,356,429.
[0009] The specific property of the organic electroluminescence ingredient which makes it ideal to TFT is :1 summarized as follows. Low-battery drive. Typically, an organic EL cell requires the electrical potential difference of the range of 4 to 10 volts depending on optical output level and a cel impedance. The electrical potential difference demanded in order to make the brightness of about 20 fL(s) is about 5 volts. This low battery is very attractive to a TFT-EL panel, because the demand to the high voltage TFT is removed. Furthermore, an organic EL cell is driven by DC or AC, and it deals in it again. As a result, a drive circuit is not more complicated and more expensive.
2) Efficient. The fluorescence effectiveness of an organic EL cell is 4 lumens per watt in height. In order to make the brightness of 20fL(s), the current density which drives an EL cell is about 1 mA/cm2. When excitation of duty is assumed 100%, it is 2 400cm. Power required since a full page panel is driven is only about 2.0W. Surely a power demand agrees on the portable criteria of a flat panel drop.
3) Manufacture of whenever [low-temperature]. An organic electroluminescence device is manufactured at an outline room temperature, and it deals in it. This is a remarkable advantage compared with the inorganic radiation device which requires an elevated-temperature (> 300 degrees C) process. The elevated-temperature process required of making inorganic EL device is incompatible with TFT.
[0010] The easiest drive to an organic EL panel is having the organic display medium sandwiched among 2 sets of electrodes (row and column) which intersect perpendicularly. By this 2 terminal method, an EL element offers both an indicator and a switching function. The nonlinear current-voltage characteristic like the diode of an organic EL device permits multiplexing of a high degree in this mode of addressing theoretically. However, :1 with some big factors which restrict the usefulness of 2 terminal methods about organic electroluminescence Lack of memory. The standup of organic electroluminescence and falling time amount are very quick, it is the order of a microsecond, and it does not have intrinsic (intrinsic) memory. Thus, using the direct-addressing approach, the EL element of the selected train must be driven so that the brightness of the moment of being proportional to the number of the scanning trains in a panel may be produced. It is difficult to attain this instantaneous brightness

depending on the magnitude of a panel. For example, the panel of 1000 scan trains which operate by the frame rate for 1 / 60 seconds is considered. The quiescent time in which per train is permitted and it deals is 17 microseconds. For example, in order to obtain the brightness to which the time average of the 20Fl(s) was carried out, the moment brightness in the train quiescent time must be 1000 times higher, namely, it is 20000Fl(s), and this is about 1 A/cm2. It is the extreme brightness obtained only by operating an organic EL cell on high current density and the electrical potential difference of about 15 - 20 volts. The prolonged dependability of the cel actuation under such extreme drive conditions is doubtful.
2) Homogeneity. The current demanded by the EL element is supplied through the bus of a row and column. Descent of IR potential along momentary high currents, therefore these buses is not remarkable as compared with EL driver voltage. Change of the potential which met the bus because the brightness-voltage characteristic of EL was nonlinear produces an uneven optical output.
[0011] It has a 200microx200micro pixel pitch, and the panel which has 0, and 1000 lines of actuation / effective field ratio of 5 and 1000 trains is considered. When a train electrode assumes that it is the indium stannic acid ghost (ITO) of resistance of a 10-ohm [/square] sheet (omega/**), resistance of the whole ITO bus line is at least 10000 ohms. The IR drop in alignment with this bus line to the moment pixel current of 800microA (2 A/cm2) is 8 volts or more. Such big fall of potential along an ITO bus causes uneven luminous radiation nonpermissible within a panel, without establishing a fixed current source in a drive method. The resistance power loss in a bus is useless at any cases. Similar analysis is made to the line electrode bus which has all the currents carried in the quiescent time to the whole line of a pixel, i.e., the additional load which conveys 0.8A to the panel of 1000 trains, and it deals in it. The IR drop obtained when sheet resistance assumed the rod of the aluminum bus of about 0.028 ohms/square 1 micrometer thickness is about 11 volts, and this must have been permitted again.
3) Electrode patternizing. One group of the rectangular electrode of an anode plate-indium stannic acid ghost is patternized by the approach of the photolithography of the conventional technique, and it deals in it. However, as for patternizing of other groups of an electrode, big difficulty appears especially to organic electroluminescence. An anode plate is magnesium by which had to be made from the metal which has a work function smaller than 4eV, and the alloy was carried out to desirable silver or other desirable metals like aluminum (see the U.S. country patent No. 4885432 by Tang etc.). The anode plate of the alloy based on the magnesium deposited on the top face of an organic layer must have been easily patternized by the means of any conventional techniques containing a photoresist. The process which applies a photoresist from an organic solvent on an EL cell influences in the organic layer dissolved under the alloy layer based on magnesium detrimentally. This causes interlaminar peeling of an organic layer from a substrate.
[0012] Other difficulties are the sensitiveness of the degree of pole of an anode plate to humidity. Even if it is applied well and developed, without a photoresist disturbing the organic layer of an EL cell, the process which etches the anode plate of the alloy based on the magnesium in an acidic solution oxidizes an anode plate, and tends to make a black point.
[0013]
[Problem(s) to be Solved by the Invention] This invention offers the active matrix 4 terminal TFT-EL device with which an organic material is used as an EL medium.
[0014]
[Means for Solving the Problem] The device consists of two TFT(s), storage capacitors, and luminous-radiation organic electroluminescence pads which have been arranged on a substrate. EL pad is electrically connected to the drain of the second TFT. The first TFT is electrically connected to the gate electrode of the second TFT, this is electrically connected to a capacitor next, and the second TFT is enabled to supply an uniformly near current to EL pad following an excitation signal between signals by that cause. The TFT-EL device of this invention is a pixel typically formed within a flat panel drop, and is a continuous layer in which EL anode plate crosses all pixels preferably.
[0015] It seems that the TFT-organic electroluminescence device of this invention is shown below, and also the thin film transistor (TFT1) of :first formed in a phase process is arranged on the top face of a

substrate. TFT1 consists of a source electrode, a drain electrode, a gate dielectric, and a gate electrode, and; gate electrode consists of a part of a gate bus. The source electrode of TFT1 is electrically connected with a source bus.

[0016] The second thin film transistor (TFT2) is arranged on the top face of a substrate again, and TFT2 consists of a source electrode, a drain electrode, a gate dielectric, and a gate electrode again. The gate electrode of TFT2 is connected as electrically as the drain electrode of the first thin film transistor. A storage capacitor is arranged on the top face of a substrate again. Working, it charges from the excitation signal source through TFT1, and this capacitor discharges in order to supply the potential uniformly near the gate electrode of TFT2 into the quiescent time.

[0017] An anode plate layer is electrically connected to the drain electrode of TFT2. In the typical application to which light is emitted through a substrate, an indicator is a transparent ingredient like an indium stannic acid ghost. A dielectric passivation layer is preferably deposited on the whole front face of a device on the source of TFT1 at least. A dielectric passivation layer is etched in order to prepare opening on a display anode.

[0018] An organic electroluminescence layer is directly arranged on the top face of an anode layer. Then, a cathode layer is directly deposited on the top face of an organic electroluminescence layer. It is combined with low-temperature (namely, 600 degrees C or less) crystallization and an annealing phase, hydrogen passivation, and the pattern technique of the conventional technique, and the TFT-EL device of this invention is made from a desirable example by the approach using low voltage and plasma enhancement chemical vacuum deposition.

[0019] A thin film transistor deposits the silicon patternized in :polycrystal silicon island formed in coincidence of the following desirable multistage story processes, and other polycrystalline silicon layers patternized in order to form the gate electrode by which self-alignment was carried out so that chemical vacuum deposition of the; diacid-ized silicon-gate electrode may be carried out and the source, a drain, and a gate electrode may be formed on a dirty thin film transistor after; ion implant are deposited.

[0020] The configuration of the pixel which has the thin film transistor which consists of polycrystalline silicon and diacid-ized silicon brings about improvement in the device engine performance, stability, repeatability, and the process effectiveness on other TFT(s). If it compares, TFT which consists of CdSe and an amorphous silicon will receive the effect of low mobility and a threshold drift.

[0021]

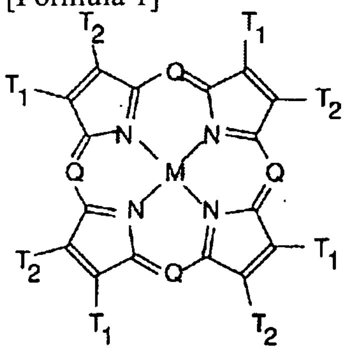
[Embodiment of the Invention] Drawing 1 shows the schematic diagram of an active matrix 4 terminal TFT-EL device. The component of each pixel contains two TFT(s), storage capacitors, and EL elements. The main descriptions of 4 terminal methods are the capacity to separate the addressing signal from EL excitation signal. An EL element is chosen through Logic TFT (T1), and the excitation power to an EL element is controlled by Power TFT (T2). A storage capacitor is enabled to stop excitation power to the EL element as which it was once chosen and by which the address was carried out. It permits thus that a circuit disregards the time amount to which the EL element was assigned to addressing, and operates by the duty cycle near 100%.

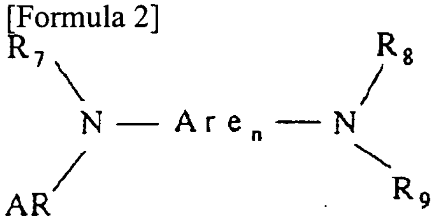
[0022] The structure of the electroluminescence device of this invention is shown in drawing 2 and 3. the substrate of this device -- an insulation -- and it is a transparent material like glass whenever [Xtal or low-temperature] preferably. Vocabulary called the transparence used on these specifications means the components which penetrate sufficient light to practical use with a display device. For example, the components which penetrate 50% or more of light in a desired frequency range are considered to be transparence. Vocabulary called glass says the glass dissolved or distorted at the temperature of about 600 degrees C or more whenever [low-temperature].

[0023] In the TFT-EL device shown in drawing 2 , TFT1 is a logic transistor to which it has a source bus (train electrode) as a data line, and it has a gate bus (line electrode) as a data line. TFT(s)2 are an EL element and serial EL power transistor. The storage capacitor is as in-series as TFT1. The anode plate of an EL element is connected to the drain of TFT2.

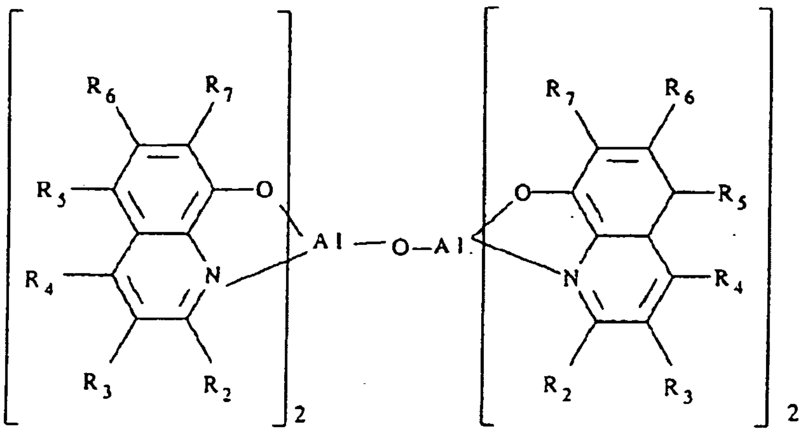
[0024] The configuration of TFT-EL of drawing 2 is shown in the sectional view of 9 from drawing 3 .

The sectional view shown in 8 from drawing 3 meets line A-A' of drawing 2 . The sectional view shown in drawing 9 meets line B-B' of drawing 2 . It deposits over an insulating substrate with a transparent polish recon layer in the first process phase, and a polish recon layer is patternized by the island by the photolithography (see drawing 4). Although a substrate is a crystal ingredient like Xtal, it is an ingredient like glass which is not more expensive whenever [low-temperature] preferably. When a glass substrate is used, in order that the whole manufacture of TFT-EL may avoid melting of glass, or distortion and may avoid outside diffusion (out-diffusion) of a dopant in an active region, it carries out at low process temperature. All manufacture phases must be thus made below by 600-degreeC preferably below 1000-degreeC to a glass substrate.
[0025] Next, the insulated-gate ingredient 42 accumulates over a polish recon island top and the front face of an insulating substrate. An insulating material is diacid-ized silicon deposited by the desirable plasma enhancement CVD (PECVD) or chemical vacuum deposition (CVD) like low voltage CVD (LPCVD). A gate oxide insulating layer is about 1000A in thickness preferably.
[0026] The layer of silicon 44 is deposited on a gate insulating layer in the next phase, and it is patternized by carrying out a photolithography on a polish recon island so that the source and a drain field may be formed in a polish recon field after the ion implant. A gate electrode material is the polish recon preferably formed from the amorphous silicon. The ion implant is electric-conduction-ized by the N type dopant which is arsenic preferably. A polish recon gate electrode is offered as a pars-basilaris-ossis-occipitalis electrode of a capacitor again (see drawing 9). In the desirable example of this invention, the thin film transistor does not use duplex (double) gate structure. Thus, manufacture is not more complicated and more expensive. The gate bus 46 is applied and patternized on an insulating layer. A gate bus is a desirable metal silicon ghost like a silicon-ized tungsten (WSi2).
[0027] In the next phase, the insulating layer which is diacid-ized silicon preferably is applied over the whole front face of a device. The contact holes 54 and 56 are cut within the second insulating layer (see drawing 5), and an electrode material is applied so that a thin film transistor and a contact may be formed (see drawing 6 and 7). The electrode material 62 attached to the source field of TFT2 forms the top-face electrode of a capacitor again (see drawing 9). A source bus and a touch-down bus are formed on the second insulating layer again (see drawing 2). The transparent electrode ingredient 72 contacts the drain field of TFT2, it is ITO preferably and this is prepared as an anode plate to an organic electroluminescence ingredient.
[0028] In the next phase, the passivation layer 74 of the insulating material which is diacid-ized silicon preferably is deposited on the front face of a device. A passivation layer is etched from ITO which left the taper-ized edge 76, and this is offered so that adhesion of the organic electroluminescence layer continued and applied may be improved. The edge with a taper is required in order to manufacture the device which can be trusted. It is because this invention uses the comparatively thin organic electroluminescence layer with a thickness of 150 to 200nm typically. A passivation layer is about 0.5 to about 1-micron thickness typically. When the edge of a passivation layer forms a perpendicular or an acute angle about an anode plate layer thus, it is easy to generate a defect by the discontinuity in an organic electroluminescence layer. In order to prevent a defect, a passivation layer must have an edge with a taper. A passivation layer can attach a taper at the include angle of 10 to 30 degrees about an anode plate layer preferably.
[0029] The organic electroluminescence layer 82 is deposited on a passivation layer and EL anode plate layer. The ingredient in the organic electroluminescence of this invention The indication as reference It is quoted (Scozzafava). [EPA] 349,265 ; (1990) U.S. patent No. 4,356,429; [of Tang] U.S. patent No. 4,539,507; [, such as VanSlyke,] U.S. patent the 4,720,432;, such as VanSlyke U.S. patent No. 4,769,292; [, such as Tang,] U.S. patent No. 4,885,211; [, such as Tang,] U.S. patent the 4,950,950;, such as Perry U.S. patent No. 5,059,861; [, such as Littman,] U.S. patent No. 5,047,687; [of VanSlyke] U.S. patent No. 5,073,446; [, such as Scozzafava,] U.S. patent No. 5,059,862; [, such as VanSlyke,] U.S. patent No. 5,061,617; [, such as VanSlyke,] The form of the organic electroluminescence device of a conventional technique like the U.S. patent [U.S. patent / of VanSlyke / No. 5,151,629 /; U.S. patent / of Tang etc. / No. 5,294,869 /;] No. 5,294,870 of Tang etc. can also be taken. EL layer consists of the

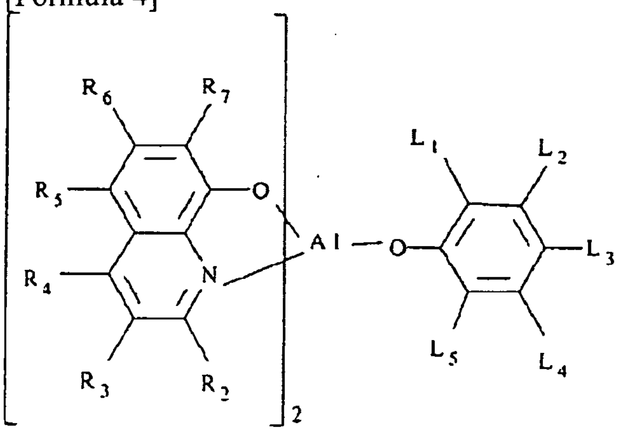
organic hole impregnation and the migration band in contact with an anode plate, and the electron injection and the migration band which form organic hole impregnation, and a migration band and junction. Hole impregnation and a migration band may be formed from a single ingredient or two or more single ingredients, and consist of a hole impregnation layer in contact with the continuous hole moving bed infixed between an anode plate, a hole impregnation layer and electron injection, and a migration band. Similarly, electron injection and a migration band may be formed from a single ingredient or two or more ingredients, and consist of an electronic injection layer in contact with the continuous electronic transition layer infixed between an anode plate and an electronic injection layer, hole impregnation, and a migration band. A hole, electronic recombination, and luminescence are generated within the electron injection which adjoins junction of electron injection, a migration band and hole impregnation, and a migration band, and a migration band. Although it deposits by vacuum evaporationo typically, it deposits with other conventional techniques again, and deals in the compound which forms an organic electroluminescence layer.
[0030] The organic material which consists of a hole impregnation layer in the desirable example is : [0031] which has the following general formulas.
[Formula 1]


[0032] A metal, a metallic oxide, or the metal halogenides T1 and T2 fill both the partial saturation six membered rings in which N or C-RM expresses hydrogen, or :Q contains alkyl or a substituent like a halogen here. While a desirable alkyl part contains the carbon atom of about 1 to 6, it constitutes an allyl compound part with desirable phenyl.
[0033] In the desirable example, the hole moving bed is an aromatic series tertiary amine. The desirable subclass of an aromatic series tertiary amine is : [0034] containing the tetra-allyl compound diamine which has the following formulas.
[Formula 2]


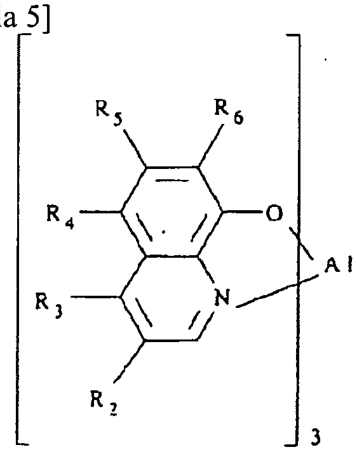
[0035] Are is a propine group here, n is the integer of 1 to 4, and it is Ar, R7, R8, and R9. It is the allyl compound group chosen, respectively. In the desirable example, luminescence, electron injection, and a migration band contain a metal oxy-NOIDO (oxinoid) compound. The desirable example of a metal oxy-NOIDO compound is : [0036] which has the following general formulas.
[Formula 3]



[0037] It is R2-R7 here. Replacement possibility is expressed. At other desirable examples, a metal oxy-NOIDO compound is : [0038] which has the following formulas.
[Formula 4]



[0039] here -- R2-R7 a definition is given above -- having -- L1-L5 -- intensive -- 12 or fewer carbon atoms -- containing -- respectively -- separate -- the hydrogen or the carbohydrate group of a carbon atom of 1 to 12 -- expressing -- L1 and L2 -- both -- or both L2 and L3 can form the united benzoring. At other desirable examples, a metal oxy-NOIDO compound is : [0040] which has the following formulas.
[Formula 5]



[0041] It is R2-R6 here. Hydrogen or other replacement possibility are expressed. It is only that the above-mentioned example expresses the existing desirable organic material which is only used within an electroluminescence layer. It does not mean that they restrict the visual field of this invention, and, generally this directs an organic electroluminescence layer. An organic electroluminescence ingredient

contains the coordination compound which has organic ligand so that the above-mentioned example may show. The TFT-EL device of this invention does not contain a pure inorganic material like ZnS.
[0042] In the next process phase, the EL anode plate 84 is deposited on the front face of a device. Although what kind of conductive ingredient is sufficient as EL anode plate, it is made from the ingredient which has a work function 4eV or less preferably (see the U.S. country patent No. 4885211 of Tang etc.). A low work function ingredient is desirable to an anode plate. It is because they emit an electron easily in an electronic transition layer. Although the metal of the lowest work function is alkali metal, under a certain conditions, the instability in the inside of those air is not practical, and is carrying out those use. Although an anode material is typically deposited by chemical vacuum deposition, other suitable deposition techniques are applicable. It was found out to EL anode plate that especially a desirable ingredient is a 10:1 magnesium:silver alloy (with atomic ratio). An anode plate is preferably applied as a continuation layer covering all the front faces of a display panel. In other examples, EL anode plate consists of a lower layer of the metal of the low work function which adjoined organic electron injection and a migration band, overlays the metal of a low work function and consists of a protective layer which protects the metal of a low work function from oxygen and humidity. A passivation layer is alternatively applied on EL anode plate layer. The anode material is transparent, the cathode material is typically opaque, and this penetrates light through an anode material. However, in the alternative example, rather than an anode plate, light is carried out [cathode] rather and emitted. In this case, cathode is light transmission nature and the anode plate is opaque. Light transmission and the practical balance of technical conductivity are the thickness of the range of five to 25 nm typically.
[0043] The desirable method of manufacturing the thin film transistor by this invention is explained below. on a first stage story, the amorphous silicon film of 2000 **20A thickness does not have a LPCVD system in a silane as reactant gas by the process pressure of 1023mTorr(s) -- it comes out and deposits at 550 degrees C. In order to crystallize the amorphous silicon film on the polycrystal film at this degree, low-temperature annealing is carried out at 550 degrees C in a vacuum for 72 hours. And a polish recon island is SF6 within a plasma reactor. It is formed of etching with the mixture of Freon 12. An active layer is 1000 **20A PECVD on a polish recon island. SiO2 A gate dielectric layer is deposited. a gate dielectric layer -- it deposits within a plasma reactor by the pressure of 0.8Torr(s) in the power level of 200W with the frequency of 450kHz for 18 minutes by 350 degrees C at 5/4 of N2 O/SiH4 ratios.
[0044] In the next phase, an amorphous silicon layer is deposited on a PECVD gate insulating layer, and is changed into polycrystalline silicon using the same conditions as the above to the first phase. A photoresist is applied, and the second polish recon layer is etched so that the self-alignment structure over the continuing ion implant phase may be formed. The second polish recon layer is about 3000A thickness preferably.
[0045] The ion implant is 2X1015/cm2 in order to dope the source, a drain, and a gate field to coincidence. It carries out by doping with arsenic with dosage at 120KeV(s). Activation of a dopant is carried out by 600-degreeC in nitrogen-gas-atmosphere mind for 2 hours. In the next phase, the silicon dioxide layer of 5000A thickness deposits in the controlled hypothermia of the conventional technique. An aluminum contact is formed of physical vacuum evaporationo, and is sintered within formation gas (10%H2 and 90%N2) for 13 minutes at 400 degrees C.
[0046] Finally hydrogen passivation of a thin film transistor is carried out within a electron cyclotron resonance reactor (ECR). ECR hydrogen plasma exposure was performed by the pressure of 1.2x10-4Torr on microwave level 900W and the frequency of 3.5GHz. Hydrogen passivation is made for 15 minutes at the substrate temperature of 300 degrees C. This process produces ****************** which has low threshold voltage, efficient carrier mobility, and excellent excellent ON / off ratio.
[0047] : which considers the drive demand to the following TFT-EL panels as an example of the property of this invention -- the number of lines -- = The number of 1000 trains = 1000-pixel dimension = 200micromx200micromEL charging coefficient = 50% frame time = 17ms line quiescent time = 17-microsecond average luminance = 20fLEL pixel current = 0.8microA duty cycle = 100%EL power source = 10v rms -- these drive demands with the property of the following which receives TFT and a

storage capacitor Suiting :TFT1 gate voltage = 10V source electrical potential difference = 10V ON state current = 2microA OFF state current = 10-11 ATFT2 gate-voltage = 10V source electrical potential difference = 10V ON state current = 2xEL pixel current = 1.6microA OFF state current = 1nA storage capacitor magnitude = Since the ON state current demand to 1pfTFT1 turns on TFT2 It is large enough, although a storage capacitor is charged in the line quiescent time (17 microseconds) to a suitable electrical potential difference (10V). Since the voltage drop on the capacitor (and TFT2 gate) in a frame period (17ms) is 2% or less, the OFF state current demand to TFT1 is small enough.

[0048] The ON state current over TFT2 is twice the EL pixel current, and is 1.6microA. This twice as many multiplier as this is because the suitable drive current for the amendment to gradual degradation of an organic EL device is permitted with actuation. The OFF state current of TFT2 influences the contrast of a panel. The OFF state current of 1nA offers the ON / office computer trust ratio of 500 times or more between the turned-on EL element and it which is not turned on. The actual contrast ratio of a panel is lower dependent on an environmental lighting factor.

[0049] 400cm2 A power demand according to an EL element independent to a full page panel is about 4W.

Power = 400cm2 x10vx0.001 A/cm2 = This power consumption exceeds 4W of power consumption by TFT. TFT2 produces the substantial power loss in TFT2 for any source-drain voltage drops which cross TFT2 because it is in-series, an EL element and. When the source-drain electrical potential difference of 5 volts is assumed, the total power loss in TFT2 is 2W. The power consumption to TFT1 is presumed not to be larger than 1W to 1000x1000 panel. Power [as opposed to / to a line (gate) drive, required power is dozens of mW order, can ignore, and / a train (source) drive] is 0.5W order (S. refer to Advances in Electronics and Electron Physics of Morozumi, P.W.Hawkes edit, Vol.77, Academic Press, and 1990). The total power consumption to a full page TFT-EL panel is about 7W thus. Actually, mean power consumption is more more small. It is because EL screen is not used 100% on the average.

[0050] The TFT-EL panel of this invention has two important advantages about the power demand to TFT-LCD. The TFT-EL power demand is comparatively independent in the first place for whether it being the multiple color offered with the color ingredient which has the monochrome or same luminescence effectiveness. By contrast, a TFT-LCD color panel requires far high power compared with black and white. It is because a transmission coefficient decreases sharply within the colorized panel by the color filter array. It is must be [a LCD back light] fixed regardless of a screen economic coefficient to the second. On the other hand, it depends for TFT-EL power consumption on this economic coefficient at altitude.

[0051] Mean power consumption is still smaller. It is because it emanates by any predetermined time amount in the application with 100 typical% or less of EL screen. Although this invention is explained to the detail especially with reference to the desirable example, various modification and amelioration are effective at the pneuma of this invention, and within the limits.

[0052]

[Effect of the Invention] : some whose important advantages of the actual panel configuration of the TFT-organic electroluminescence device of this invention and drive arrangement are as follows -- 1 Because is the continuous layer, a chisel decision is made with the display ITO pad relevant to the property magnitude of TFT, and both an organic electroluminescence pad and the anode plate of pixel resolution are independent of the organic compound of an EL cell, or an anode plate by it.

2) An anode plate is continuation and common to all pixels. It does not need patternizing to the resolution of a pixel. Therefore, the difficulty which patternizes the anode plate in 2 terminal methods was removed.

3) Since the address and an excitation signal are separated, the number of scanning lines is not restricted any longer by the short line quiescent time in a frame period. Each scanning line operates near the duty factor 100%. High resolution may be used within a display panel, while a majority of scanning lines maintain uniform reinforcement.

4) The dependability of an organic EL device is reinforced. That is because it operates by the duty factor 100% on a low current consistency (1 mA/cm2) and an electrical potential difference (5V).

5) IR potential fall which met the bus at the reason using the common anode plate and low current consistency which are needed since an EL element is driven is not remarkable. Therefore, the homogeneity of a panel is not notably influenced with the magnitude of a panel.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the electroluminescence display panel which used the organic electroluminescence thin film as a thin film transistor (TFT) and a radiation medium as an active matrix addressing element.

[Translation done.]

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[Translation done.]

PRIOR ART

[Description of the Prior Art] Rapid development of a flat panel drop (FPD) technique made possible a high quality large field, full color, and a high resolution drop. These drops enabled new application with a laptop computer or an electronic product like Pocket TV. The liquid crystal display (LCD) appeared as selection of the drop in a commercial scene in these FPD techniques. It set up the technical standards with which other FPD techniques are compared again. LCD -- a panel -- an example -- the following -- containing -- : -- (-- one --) -- a workstation -- ** -- 14 -- " -- 16 - a color -- LCD -- a panel (IBM and Toshiba --) 1989 (see SID Digest by KIchikawa, S.Suzuki, H.Matino, T.Aoki, T.Higuchi, Y.Oano, etc., and 226 (1989)), (2) -- 6" -- full color LCD-TV (Philips --) 1987 It Hemmings(es). M. -- J.Powell, J.A.Chapman, A.G.Knapp, I.D.French, J.R.Hughes, A.D.Pearson, M.Allinson, M.J.Edwards, R.A.Ford, and M.C. -- O. Proceeding by F.Hill, D.H.Nicholls, N.KWright, etc., International Display Conference, and 63 and 1987 are referred to. (3) -- 4" -- full color LCD-TV (model LQ 424A01) (see the Sharp Corporation Technical Literature for model LQ424A01) -- (4) One mega pixel color TFT-LCD (General Electric) (D. refer to E.Castleberry, SID Digest by G.E.Possin, and 232 (1988)). All the bibliographies containing a patent and a publication are quoted here so that it may reappear completely below.
[0004] The common description in these LCD panels is use of a thin film transistor (TFT) in an active addressing method, and this eases a limit of direct addressing (S. refer to Advances in Electronics and Electron Physics by Morozumi, P.W.Hawkes edit, Vol.77, and Academic Press 1990). It is most that a success of a LCD technique is based on the rapid advance of manufacture of the large field TFT (mainly amorphous silicon TFT). The almost ideal adaptation between a TFT switching characteristic and a electron optics LCD display element plays a role of a key again.
[0005] The main faults of a TFT-LCD panel are that a bright back light is the need. The transmission coefficient of this of TFT-LCD is because it is small especially by the color panel. Typically, a transmission coefficient is about 2 to 3% (S. refer to Advances in Electronics and ElectronPhysics by Morozumi, P.W.Hawkes edit, Vol.77, and AcademicPress 1990). The power consumption to a TFT-LCD panel with a back light is remarkable, and it influences so that it may go back to application of the pocket mold drop which needs dc-battery actuation.
[0006] The need for a back light spoils the miniaturization of a flat panel again. For example, it must be increased by the depth of a panel in order to contain a back light unit. When the cold cathode lamp of the shape of typical tubing is used, about 3/of additional depth is 4 to 1 inch. A back light applies excessive weight to FPD again. The ideal solution to the above-mentioned limit is a low power radiation drop which removes the need for a back light. Especially an attractive candidate is a thin film transistor electroluminescence (TFT-EL) drop. The address of each pixel is carried out so that light may be emitted, and an auxiliary back light is not required of a TFT-EL indicator. The TFT-EL method was proposed by Fischer in 1971 (A. refer to IEEE Trans.Electron Devices by G.Fischer, and 802 (971)). ZnS to which disintegration of the method of Fischer was carried out is used as an EL medium.
[0007] It was reported that the TFT-EL panel (6") of the prototype which was successful in 1975 was made by Brody using CdSe as a TFT ingredient etc. by using ZnS as EL element (T. refer to IEEE Trans.ElectronDevices by P.Brody, F.C.Luo, A.P.Szepesi, D.H.Davies, etc., and 22,739 (1975)). Since

ZnS-EL needs high driver voltage 100 volts or more, it is Switching CdSe. A TFT element must be designed so that such high-voltage vibration may be treated. Then, the dependability of the high voltage TFT became doubtful. Ultimately, TFT-EL based on ZnS did not succeed in competition with TFT-LCD. : whose U.S. country patent which indicates a TFT-EL technique is as follows -- No. 3807037, No. 3885196, No. 3913090, No. 4006383, No. 4042854, No. 4523189, and No. 4602192.

[0008] The organic electroluminescence ingredient has been device-ized in recent years. These ingredients itself as a candidate to the display medium in a TFT-EL device It suggests (C.). [Appl.Phys.Lett. by W.Tang and S.A.VanSlyke, 51,913 (1987) and C.W.Tang, S.A.VanSlyke,] [C.H.C<TXF FR=0002 HE=250] WI=080 LX=1100 LY=0300> Refer to J.Appl.Phys. by hen, and 65 and 3610 (1989). : in which an organic electroluminescence medium has two important advantages --; which has the effectiveness in which they are higher -- they have a low electrical-potential-difference demand. The latter property differs from other thin film radiation devices. : with the following indication of the TFT-EL device whose EL is an organic material -- the U.S. country patent No. 5,073,446, No. 5,047,687,; of 5,059,861 No. No. 5,294,870, No. 5,151,629, No. 5,276,380, No. 5,061,569, No. 4,720,432, No. 4,539,507, No. 5,150,006, No. 4,950,950, and No. 4,356,429.

[0009] The specific property of the organic electroluminescence ingredient which makes it ideal to TFT is :1 summarized as follows. Low-battery drive. Typically, an organic EL cell requires the electrical potential difference of the range of 4 to 10 volts depending on optical output level and a cel impedance. The electrical potential difference demanded in order to make the brightness of about 20 fL(s) is about 5 volts. This low battery is very attractive to a TFT-EL panel, because the demand to the high voltage TFT is removed. Furthermore, an organic EL cell is driven by DC or AC, and it deals in it again. As a result, a drive circuit is not more complicated and more expensive.

2) Efficient. The fluorescence effectiveness of an organic EL cell is 4 lumens per watt in height. In order to make the brightness of 20fL(s), the current density which drives an EL cell is about 1 mA/cm2. When excitation of duty is assumed 100%, it is 2 400cm. Power required since a full page panel is driven is only about 2.0W. Surely a power demand agrees on the portable criteria of a flat panel drop.

3) Manufacture of whenever [low-temperature]. An organic electroluminescence device is manufactured at an outline room temperature, and it deals in it. This is a remarkable advantage compared with the inorganic radiation device which requires an elevated-temperature (> 300 degrees C) process. The elevated-temperature process required of making inorganic EL device is incompatible with TFT.

[0010] The easiest drive to an organic EL panel is having the organic display medium sandwiched among 2 sets of electrodes (row and column) which intersect perpendicularly. By this 2 terminal method, an EL element offers both an indicator and a switching function. The nonlinear current-voltage characteristic like the diode of an organic EL device permits multiplexing of a high degree in this mode of addressing theoretically. However, :1 with some big factors which restrict the usefulness of 2 terminal methods about organic electroluminescence Lack of memory. The standup of organic electroluminescence and falling time amount are very quick, it is the order of a microsecond, and it does not have intrinsic (intrinsic) memory. Thus, using the direct-addressing approach, the EL element of the selected train must be driven so that the brightness of the moment of being proportional to the number of the scanning trains in a panel may be produced. It is difficult to attain this instantaneous brightness depending on the magnitude of a panel. For example, the panel of 1000 scan trains which operate by the frame rate for 1 / 60 seconds is considered. The quiescent time in which per train is permitted and it deals is 17 microseconds. For example, in order to obtain the brightness to which the time average of the 20Fl(s) was carried out, the moment brightness in the train quiescent time must be 1000 times higher, namely, it is 20000Fl(s), and this is about 1 A/cm2. It is the extreme brightness obtained only by operating an organic EL cell on high current density and the electrical potential difference of about 15 - 20 volts. The prolonged dependability of the cel actuation under such extreme drive conditions is doubtful.

2) Homogeneity. The current demanded by the EL element is supplied through the bus of a row and column. Descent of IR potential along momentary high currents, therefore these buses is not remarkable

as compared with EL driver voltage. Change of the potential which met the bus because the brightness-voltage characteristic of EL was nonlinear produces an uneven optical output.
[0011] It has a 200microx200micro pixel pitch, and the panel which has 0, and 1000 lines of actuation / effective field ratio of 5 and 1000 trains is considered. When a train electrode assumes that it is the indium stannic acid ghost (ITO) of resistance of a 10-ohm [/square] sheet (omega/**), resistance of the whole ITO bus line is at least 10000 ohms. The IR drop in alignment with this bus line to the moment pixel current of 800microA (2 A/cm2) is 8 volts or more. Such big fall of potential along an ITO bus causes uneven luminous radiation nonpermissible within a panel, without establishing a fixed current source in a drive method. The resistance power loss in a bus is useless at any cases. Similar analysis is made to the line electrode bus which has all the currents carried in the quiescent time to the whole line of a pixel, i.e., the additional load which conveys 0.8A to the panel of 1000 trains, and it deals in it. The IR drop obtained when sheet resistance assumed the rod of the aluminum bus of about 0.028 ohms/square 1 micrometer thickness is about 11 volts, and this must have been permitted again.
3) Electrode patternizing. One group of the rectangular electrode of an anode plate-indium stannic acid ghost is patternized by the approach of the photolithography of the conventional technique, and it deals in it. However, as for patternizing of other groups of an electrode, big difficulty appears especially to organic electroluminescence. An anode plate is magnesium by which had to be made from the metal which has a work function smaller than 4eV, and the alloy was carried out to desirable silver or other desirable metals like aluminum (see the U.S. country patent No. 4885432 by Tang etc.). The anode plate of the alloy based on the magnesium deposited on the top face of an organic layer must have been easily patternized by the means of any conventional techniques containing a photoresist. The process which applies a photoresist from an organic solvent on an EL cell influences in the organic layer dissolved under the alloy layer based on magnesium detrimentally. This causes interlaminar peeling of an organic layer from a substrate.
[0012] Other difficulties are the sensitiveness of the degree of pole of an anode plate to humidity. Even if it is applied well and developed, without a photoresist disturbing the organic layer of an EL cell, the process which etches the anode plate of the alloy based on the magnesium in an acidic solution oxidizes an anode plate, and tends to make a black point.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] : some whose important advantages of the actual panel configuration of the TFT-organic electroluminescence device of this invention and drive arrangement are as follows -- 1 Because is the continuous layer, a chisel decision is made with the display ITO pad relevant to the property magnitude of TFT, and both an organic electroluminescence pad and the anode plate of pixel resolution are independent of the organic compound of an EL cell, or an anode plate by it.
2) An anode plate is continuation and common to all pixels. It does not need patternizing to the resolution of a pixel. Therefore, the difficulty which patternizes the anode plate in 2 terminal methods was removed.
3) Since the address and an excitation signal are separated, the number of scanning lines is not restricted any longer by the short line quiescent time in a frame period. Each scanning line operates near the duty factor 100%. High resolution may be used within a display panel, while a majority of scanning lines maintain uniform reinforcement.
4) The dependability of an organic EL device is reinforced. That is because it operates by the duty factor 100% on a low current consistency (1 mA/cm2) and an electrical potential difference (5V).
5) IR potential fall which met the bus at the reason using the common anode plate and low current consistency which are needed since an EL element is driven is not remarkable. Therefore, the homogeneity of a panel is not notably influenced with the magnitude of a panel.

[Translation done.]

* NOTICES *

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] This invention offers the active matrix 4 terminal TFT-EL device with which an organic material is used as an EL medium.

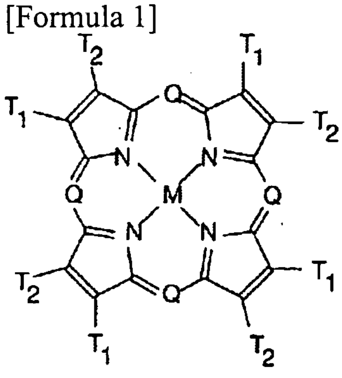
[Translation done.]

MEANS

[Means for Solving the Problem] The device consists of two TFT(s), storage capacitors, and luminous-radiation organic electroluminescence pads which have been arranged on a substrate. EL pad is electrically connected to the drain of the second TFT. The first TFT is electrically connected to the gate electrode of the second TFT, this is electrically connected to a capacitor next, and the second TFT is enabled to supply an uniformly near current to EL pad following an excitation signal between signals by that cause. The TFT-EL device of this invention is a pixel typically formed within a flat panel drop, and is a continuous layer in which EL anode plate crosses all pixels preferably.
[0015] It seems that the TFT-organic electroluminescence device of this invention is shown below, and also the thin film transistor (TFT1) of :first formed in a phase process is arranged on the top face of a substrate. TFT1 consists of a source electrode, a drain electrode, a gate dielectric, and a gate electrode, and; gate electrode consists of a part of a gate bus. The source electrode of TFT1 is electrically connected with a source bus.
[0016] The second thin film transistor (TFT2) is arranged on the top face of a substrate again, and TFT2 consists of a source electrode, a drain electrode, a gate dielectric, and a gate electrode again. The gate electrode of TFT2 is connected as electrically as the drain electrode of the first thin film transistor. A storage capacitor is arranged on the top face of a substrate again. Working, it charges from the excitation signal source through TFT1, and this capacitor discharges in order to supply the potential uniformly near the gate electrode of TFT2 into the quiescent time.
[0017] An anode plate layer is electrically connected to the drain electrode of TFT2. In the typical application to which light is emitted through a substrate, an indicator is a transparent ingredient like an indium stannic acid ghost. A dielectric passivation layer is preferably deposited on the whole front face of a device on the source of TFT1 at least. A dielectric passivation layer is etched in order to prepare opening on a display anode.
[0018] An organic electroluminescence layer is directly arranged on the top face of an anode layer. Then, a cathode layer is directly deposited on the top face of an organic electroluminescence layer. It is combined with low-temperature (namely, 600 degrees C or less) crystallization and an annealing phase, hydrogen passivation, and the pattern technique of the conventional technique, and the TFT-EL device of this invention is made from a desirable example by the approach using low voltage and plasma enhancement chemical vacuum deposition.
[0019] A thin film transistor deposits the silicon patternized in :polycrystal silicon island formed in coincidence of the following desirable multistage story processes, and other polycrystalline silicon layers patternized in order to form the gate electrode by which self-alignment was carried out so that chemical vacuum deposition of the; diacid-ized silicon-gate electrode may be carried out and the source, a drain, and a gate electrode may be formed on a dirty thin film transistor after; ion implant are deposited.
[0020] The configuration of the pixel which has the thin film transistor which consists of polycrystalline silicon and diacid-ized silicon brings about improvement in the device engine performance, stability, repeatability, and the process effectiveness on other TFT(s). If it compares, TFT which consists of CdSe

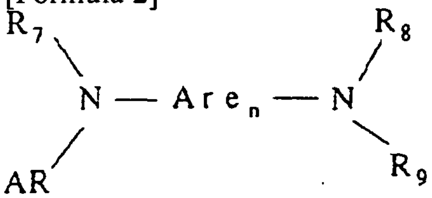
and an amorphous silicon will receive the effect of low mobility and a threshold drift.
[0021]
[Embodiment of the Invention] Drawing 1 shows the schematic diagram of an active matrix 4 terminal TFT-EL device. The component of each pixel contains two TFT(s), storage capacitors, and EL elements. The main descriptions of 4 terminal methods are the capacity to separate the addressing signal from EL excitation signal. An EL element is chosen through Logic TFT (T1), and the excitation power to an EL element is controlled by Power TFT (T2). A storage capacitor is enabled to stop excitation power to the EL element as which it was once chosen and by which the address was carried out. It permits thus that a circuit disregards the time amount to which the EL element was assigned to addressing, and operates by the duty cycle near 100%.
[0022] The structure of the electroluminescence device of this invention is shown in drawing 2 and 3. the substrate of this device -- an insulation -- and it is a transparent material like glass whenever [Xtal or low-temperature] preferably. Vocabulary called the transparence used on these specifications means the components which penetrate sufficient light to practical use with a display device. For example, the components which penetrate 50% or more of light in a desired frequency range are considered to be transparence. Vocabulary called glass says the glass dissolved or distorted at the temperature of about 600 degrees C or more whenever [low-temperature].
[0023] In the TFT-EL device shown in drawing 2 , TFT1 is a logic transistor to which it has a source bus (train electrode) as a data line, and it has a gate bus (line electrode) as a data line. TFT(s)2 are an EL element and serial EL power transistor. The storage capacitor is as in-series as TFT1. The anode plate of an EL element is connected to the drain of TFT2.
[0024] The configuration of TFT-EL of drawing 2 is shown in the sectional view of 9 from drawing 3 . The sectional view shown in 8 from drawing 3 meets line A-A' of drawing 2 . The sectional view shown in drawing 9 meets line B-B' of drawing 2 . It deposits over an insulating substrate with a transparent polish recon layer in the first process phase, and a polish recon layer is patternized by the island by the photolithography (see drawing 4). Although a substrate is a crystal ingredient like Xtal, it is an ingredient like glass which is not more expensive whenever [low-temperature] preferably. When a glass substrate is used, in order that the whole manufacture of TFT-EL may avoid melting of glass, or distortion and may avoid outside diffusion (out-diffusion) of a dopant in an active region, it carries out at low process temperature. All manufacture phases must be thus made below by 600-degreeC preferably below 1000-degreeC to a glass substrate.
[0025] Next, the insulated-gate ingredient 42 accumulates over a polish recon island top and the front face of an insulating substrate. An insulating material is diacid-ized silicon deposited by the desirable plasma enhancement CVD (PECVD) or chemical vacuum deposition (CVD) like low voltage CVD (LPCVD). A gate oxide insulating layer is about 1000A in thickness preferably.
[0026] The layer of silicon 44 is deposited on a gate insulating layer in the next phase, and it is patternized by carrying out a photolithography on a polish recon island so that the source and a drain field may be formed in a polish recon field after the ion implant. A gate electrode material is the polish recon preferably formed from the amorphous silicon. The ion implant is electric-conduction-ized by the N type dopant which is arsenic preferably. A polish recon gate electrode is offered as a pars-basilaris-ossis-occipitalis electrode of a capacitor again (see drawing 9). In the desirable example of this invention, the thin film transistor does not use duplex (double) gate structure. Thus, manufacture is not more complicated and more expensive. The gate bus 46 is applied and patternized on an insulating layer. A gate bus is a desirable metal silicon ghost like a silicon-ized tungsten (WSi2).
[0027] In the next phase, the insulating layer which is diacid-ized silicon preferably is applied over the whole front face of a device. The contact holes 54 and 56 are cut within the second insulating layer (see drawing 5), and an electrode material is applied so that a thin film transistor and a contact may be formed (see drawing 6 and 7). The electrode material 62 attached to the source field of TFT2 forms the top-face electrode of a capacitor again (see drawing 9). A source bus and a touch-down bus are formed on the second insulating layer again (see drawing 2). The transparent electrode ingredient 72 contacts the drain field of TFT2, it is ITO preferably and this is prepared as an anode plate to an organic

electroluminescence ingredient.
[0028] In the next phase, the passivation layer 74 of the insulating material which is diacid-ized silicon preferably is deposited on the front face of a device. A passivation layer is etched from ITO which left the taper-ized edge 76, and this is offered so that adhesion of the organic electroluminescence layer continued and applied may be improved. The edge with a taper is required in order to manufacture the device which can be trusted. It is because this invention uses the comparatively thin organic electroluminescence layer with a thickness of 150 to 200nm typically. A passivation layer is about 0.5 to about 1-micron thickness typically. When the edge of a passivation layer forms a perpendicular or an acute angle about an anode plate layer thus, it is easy to generate a defect by the discontinuity in an organic electroluminescence layer. In order to prevent a defect, a passivation layer must have an edge with a taper. A passivation layer can attach a taper at the include angle of 10 to 30 degrees about an anode plate layer preferably.
[0029] The organic electroluminescence layer 82 is deposited on a passivation layer and EL anode plate layer. The ingredient in the organic electroluminescence of this invention The indication as reference It is quoted (Scozzafava). [EPA] 349,265 ; (1990) U.S. patent No. 4,356,429; [of Tang] U.S. patent No. 4,539,507; [, such as VanSlyke,] U.S. patent the 4,720,432;, such as VanSlyke U.S. patent No. 4,769,292; [, such as Tang,] U.S. patent No. 4,885,211; [, such as Tang,] U.S. patent the 4,950,950;, such as Perry U.S. patent No. 5,059,861; [, such as Littman,] U.S. patent No. 5,047,687; [of VanSlyke] U.S. patent No. 5,073,446; [, such as Scozzafava,] U.S. patent No. 5,059,862; [, such as VanSlyke,] U.S. patent No. 5,061,617; [, such as VanSlyke,] The form of the organic electroluminescence device of a conventional technique like the U.S. patent [U.S. patent / of VanSlyke / No. 5,151,629 /; U.S. patent / of Tang etc. / No. 5,294,869 /;] No. 5,294,870 of Tang etc. can also be taken. EL layer consists of the organic hole impregnation and the migration band in contact with an anode plate, and the electron injection and the migration band which form organic hole impregnation, and a migration band and junction. Hole impregnation and a migration band may be formed from a single ingredient or two or more single ingredients, and consist of a hole impregnation layer in contact with the continuous hole moving bed infixed between an anode plate, a hole impregnation layer and electron injection, and a migration band. Similarly, electron injection and a migration band may be formed from a single ingredient or two or more ingredients, and consist of an electronic injection layer in contact with the continuous electronic transition layer infixed between an anode plate and an electronic injection layer, hole impregnation, and a migration band. A hole, electronic recombination, and luminescence are generated within the electron injection which adjoins junction of electron injection, a migration band and hole impregnation, and a migration band, and a migration band. Although it deposits by vacuum evaporationo typically, it deposits with other conventional techniques again, and deals in the compound which forms an organic electroluminescence layer.
[0030] The organic material which consists of a hole impregnation layer in the desirable example is :
[0031] which has the following general formulas.
[Formula 1]

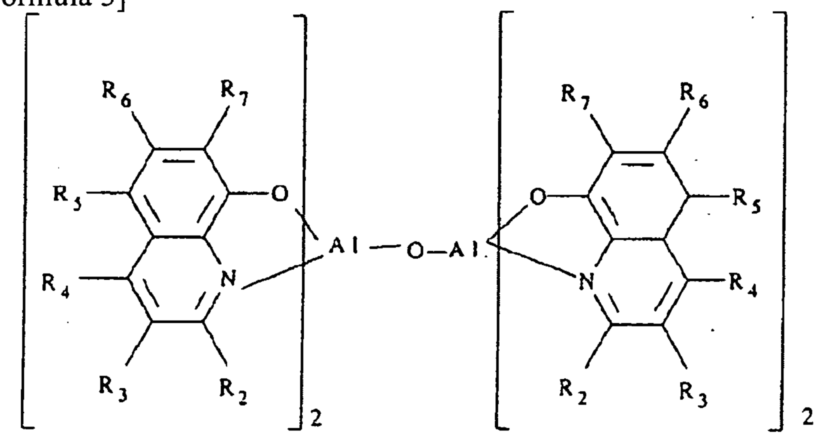


[0032] A metal, a metallic oxide, or the metal halogenides T1 and T2 fill both the partial saturation six membered rings in which N or C-RM expresses hydrogen, or :Q contains alkyl or a substituent like a

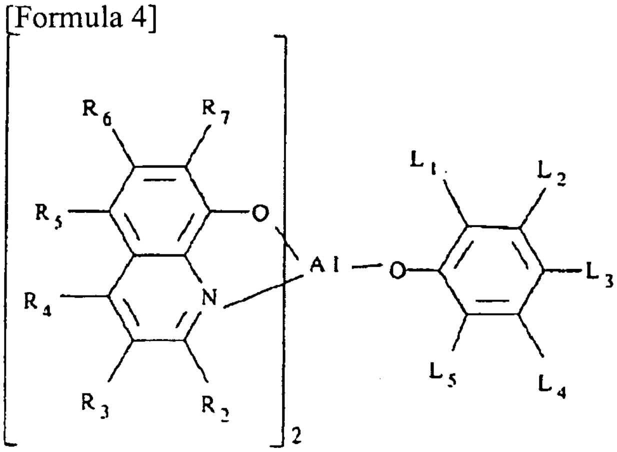
halogen here. While a desirable alkyl part contains the carbon atom of about 1 to 6, it constitutes an allyl compound part with desirable phenyl.
[0033] In the desirable example, the hole moving bed is an aromatic series tertiary amine. The desirable subclass of an aromatic series tertiary amine is : [0034] containing the tetra-allyl compound diamine which has the following formulas.
[Formula 2]



[0035] Are is a propine group here, n is the integer of 1 to 4, and it is Ar, R7, R8, and R9. It is the allyl compound group chosen, respectively. In the desirable example, luminescence, electron injection, and a migration band contain a metal oxy-NOIDO (oxinoid) compound. The desirable example of a metal oxy-NOIDO compound is : [0036] which has the following general formulas.
[Formula 3]

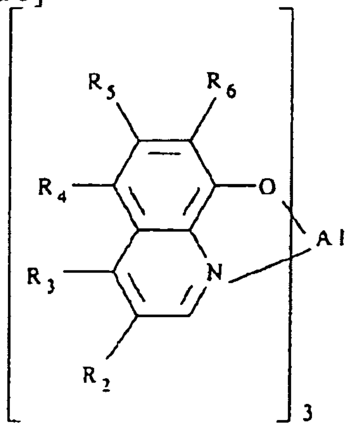


[0037] It is R2-R7 here. Replacement possibility is expressed. At other desirable examples, a metal oxy-NOIDO compound is : [0038] which has the following formulas.
[Formula 4]



[0039] here -- R2-R7 a definition is given above -- having -- L1-L5 -- intensive -- 12 or fewer carbon atoms -- containing -- respectively -- separate -- the hydrogen or the carbohydrate group of a carbon atom of 1 to 12 -- expressing -- L1 and L2 -- both -- or both L2 and L3 can form the united benzoring. At other desirable examples, a metal oxy-NOIDO compound is : [0040] which has the following formulas.

[Formula 5]



[0041] It is R2-R6 here. Hydrogen or other replacement possibility are expressed. It is only that the above-mentioned example expresses the existing desirable organic material which is only used within an electroluminescence layer. It does not mean that they restrict the visual field of this invention, and, generally this directs an organic electroluminescence layer. An organic electroluminescence ingredient contains the coordination compound which has organic ligand so that the above-mentioned example may show. The TFT-EL device of this invention does not contain a pure inorganic material like ZnS.
[0042] In the next process phase, the EL anode plate 84 is deposited on the front face of a device. Although what kind of conductive ingredient is sufficient as EL anode plate, it is made from the ingredient which has a work function 4eV or less preferably (see the U.S. country patent No. 4885211 of Tang etc.). A low work function ingredient is desirable to an anode plate. It is because they emit an electron easily in an electronic transition layer. Although the metal of the lowest work function is alkali metal, under a certain conditions, the instability in the inside of those air is not practical, and is carrying out those use. Although an anode material is typically deposited by chemical vacuum deposition, other suitable deposition techniques are applicable. It was found out to EL anode plate that especially a desirable ingredient is a 10:1 magnesium:silver alloy (with atomic ratio). An anode plate is preferably applied as a continuation layer covering all the front faces of a display panel. In other examples, EL anode plate consists of a lower layer of the metal of the low work function which adjoined organic electron injection and a migration band, overlays the metal of a low work function and consists of a protective layer which protects the metal of a low work function from oxygen and humidity. A passivation layer is alternatively applied on EL anode plate layer. The anode material is transparent, the cathode material is typically opaque, and this penetrates light through an anode material. However, in the alternative example, rather than an anode plate, light is carried out [cathode] rather and emitted. In this case, cathode is light transmission nature and the anode plate is opaque. Light transmission and the practical balance of technical conductivity are the thickness of the range of five to 25 nm typically.
[0043] The desirable method of manufacturing the thin film transistor by this invention is explained below. on a first stage story, the amorphous silicon film of 2000 **20A thickness does not have a LPCVD system in a silane as reactant gas by the process pressure of 1023mTorr(s) -- it comes out and deposits at 550 degrees C. In order to crystallize the amorphous silicon film on the polycrystal film at this degree, low-temperature annealing is carried out at 550 degrees C in a vacuum for 72 hours. And a polish recon island is SF6 within a plasma reactor. It is formed of etching with the mixture of Freon 12. An active layer is 1000 **20A PECVD on a polish recon island. SiO2 A gate dielectric layer is deposited. a gate dielectric layer -- it deposits within a plasma reactor by the pressure of 0.8Torr(s) in the power level of 200W with the frequency of 450kHz for 18 minutes by 350 degrees C at 5/4 of N2 O/SiH4 ratios.
[0044] In the next phase, an amorphous silicon layer is deposited on a PECVD gate insulating layer, and is changed into polycrystalline silicon using the same conditions as the above to the first phase. A photoresist is applied, and the second polish recon layer is etched so that the self-alignment structure

over the continuing ion implant phase may be formed. The second polish recon layer is about 3000A thickness preferably.
[0045] The ion implant is 2X1015/cm2 in order to dope the source, a drain, and a gate field to coincidence. It carries out by doping with arsenic with dosage at 120KeV(s). Activation of a dopant is carried out by 600-degreeC in nitrogen-gas-atmosphere mind for 2 hours. In the next phase, the silicon dioxide layer of 5000A thickness deposits in the controlled hypothermia of the conventional technique. An aluminum contact is formed of physical vacuum evaporationo, and is sintered within formation gas (10%H2 and 90%N2) for 13 minutes at 400 degrees C.
[0046] Finally hydrogen passivation of a thin film transistor is carried out within a electron cyclotron resonance reactor (ECR). ECR hydrogen plasma exposure was performed by the pressure of 1.2x10-4Torr on microwave level 900W and the frequency of 3.5GHz. Hydrogen passivation is made for 15 minutes at the substrate temperature of 300 degrees C. This process produces ***************** which has low threshold voltage, efficient carrier mobility, and excellent excellent ON / off ratio.
[0047] : which considers the drive demand to the following TFT-EL panels as an example of the property of this invention -- the number of lines -- = The number of 1000 trains = 1000-pixel dimension = 200micromx200micromEL charging coefficient = 50% frame time = 17ms line quiescent time = 17-microsecond average luminance = 20fLEL pixel current = 0.8microA duty cycle = 100%EL power source = 10v rms -- these drive demands with the property of the following which receives TFT and a storage capacitor Suiting :TFT1 gate voltage = 10V source electrical potential difference = 10V ON state current = 2microA OFF state current = 10-11 ATFT2 gate-voltage = 10V source electrical potential difference = 10V ON state current = 2xEL pixel current = 1.6microA OFF state current = 1nA storage capacitor magnitude = Since the ON state current demand to 1pfTFT1 turns on TFT2 It is large enough, although a storage capacitor is charged in the line quiescent time (17 microseconds) to a suitable electrical potential difference (10V). Since the voltage drop on the capacitor (and TFT2 gate) in a frame period (17ms) is 2% or less, the OFF state current demand to TFT1 is small enough.
[0048] The ON state current over TFT2 is twice the EL pixel current, and is 1.6microA. This twice as many multiplier as this is because the suitable drive current for the amendment to gradual degradation of an organic EL device is permitted with actuation. The OFF state current of TFT2 influences the contrast of a panel. The OFF state current of 1nA offers the ON / office computer trust ratio of 500 times or more between the turned-on EL element and it which is not turned on. The actual contrast ratio of a panel is lower dependent on an environmental lighting factor.
[0049] 400cm2 A power demand according to an EL element independent to a full page panel is about 4W.
Power = 400cm2 x10vx0.001 A/cm2 = This power consumption exceeds 4W of power consumption by TFT. TFT2 produces the substantial power loss in TFT2 for any source-drain voltage drops which cross TFT2 because it is in-series, an EL element and. When the source-drain electrical potential difference of 5 volts is assumed, the total power loss in TFT2 is 2W. The power consumption to TFT1 is presumed not to be larger than 1W to 1000x1000 panel. Power [as opposed to / to a line (gate) drive, required power is dozens of mW order, can ignore, and / a train (source) drive] is 0.5W order (S. refer to Advances in Electronics and Electron Physics of Morozumi, P.W.Hawkes edit, Vol.77, Academic Press, and 1990). The total power consumption to a full page TFT-EL panel is about 7W thus. Actually, mean power consumption is more more small. It is because EL screen is not used 100% on the average.
[0050] The TFT-EL panel of this invention has two important advantages about the power demand to TFT-LCD. The TFT-EL power demand is comparatively independent in the first place for whether it being the multiple color offered with the color ingredient which has the monochrome or same luminescence effectiveness. By contrast, a TFT-LCD color panel requires far high power compared with black and white. It is because a transmission coefficient decreases sharply within the colorized panel by the color filter array. It is must be [a LCD back light] fixed regardless of a screen economic coefficient to the second. On the other hand, it depends for TFT-EL power consumption on this economic coefficient at altitude.
[0051] Mean power consumption is still smaller. It is because it emanates by any predetermined time

amount in the application with 100 typical% or less of EL screen. Although this invention is explained to the detail especially with reference to the desirable example, various modification and amelioration are effective at the pneuma of this invention, and within the limits.

[Translation done.]

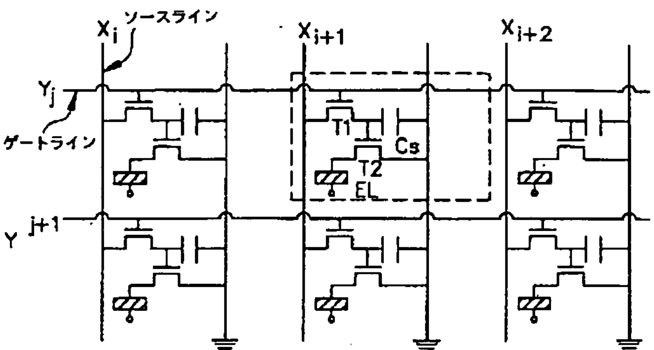
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The schematic diagram of an active matrix 4 terminal TFT-EL device is shown.
[Drawing 2] It is the top view of the 4 terminal TFT-EL device of this invention.
[Drawing 3] It is a sectional view in alignment with line A-A' of drawing 2 .
[Drawing 4] It is a sectional view in alignment with line A-A' which shows the process which forms the self-alignment TFT structure over the ion implant.
[Drawing 5] It is a sectional view in alignment with line A-A' which shows the process phase which carries out opening of the contact cutting to the source of a thin film transistor, and deposition of the passivation oxidizing zone to a drain field.
[Drawing 6] It is a sectional view in alignment with line A-A' which shows deposition of an aluminum electrode.
[Drawing 7] It is a sectional view in alignment with line A-A' which shows deposition with the passivation layer partially etched from the front face of a display anode plate and a display anode plate.
[Drawing 8] It is a sectional view in alignment with line A-A' which shows an electroluminescence and the phase of deposition of an anode plate.
[Drawing 9] It is a sectional view in alignment with line B-B' of drawing 2 .
[Description of Notations]
T1, T2 Thin film transistor
CS Capacitor
EL Electroluminescence layer
42 Gate Ingredient
44 Silicon Layer
46 Gate Bus
52 Insulating Layer
54 56 Contact hole
62 72 Electrode material
74 Passivation Layer
76 Edge with Taper
82 EL Layer
84 EL Cathode

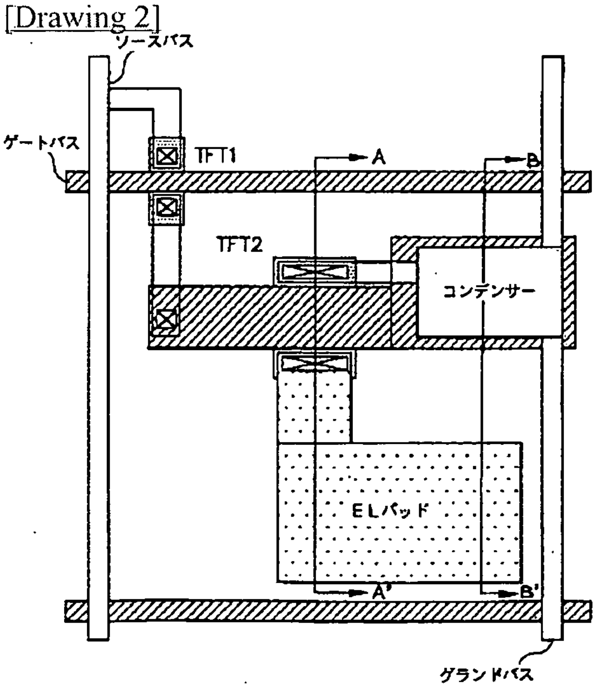
[Translation done.]

DRAWINGS

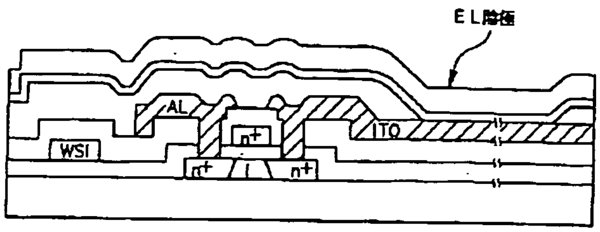
[Drawing 1]



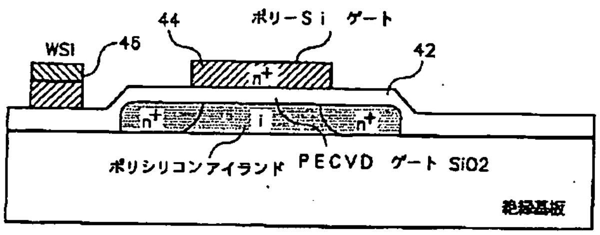
[Drawing 2]



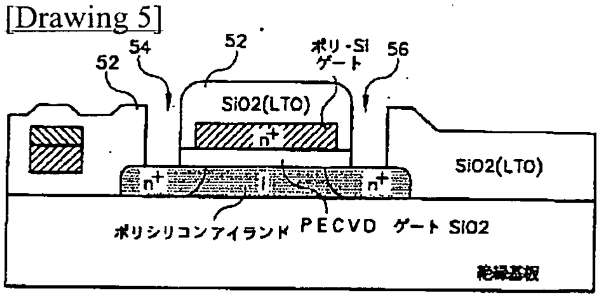
[Drawing 3]



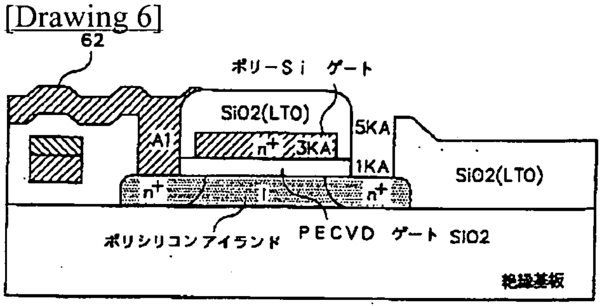
[Drawing 4]



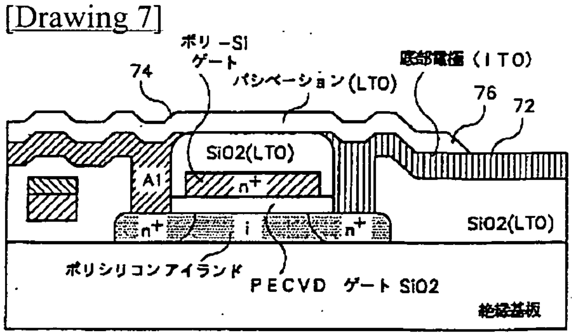
[Drawing 5]



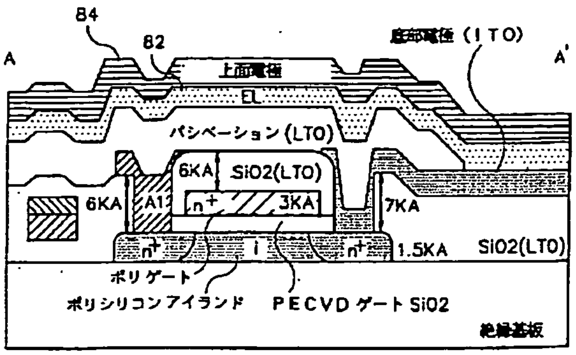
[Drawing 6]



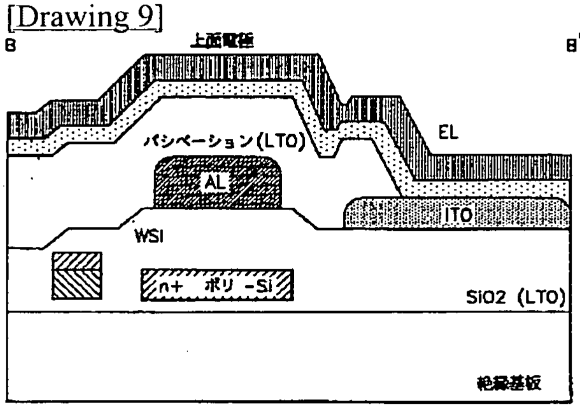
[Drawing 7]



[Drawing 8]



[Drawing 9]



[Translation done.]